Space Weather Technical Forecast

Issued on Saturday, 15 June 2024 at 00:12 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of G1/Minor Geomagnetic Storm Day 1 into Day 2 (15-16 Jun). Isolated M-flares (R1-R2 radio blackouts) likely throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity was Moderate with one isolated M-flare, an M2.4 peaking at 14/0432 UTC attributed to AR3712 in the southeast. There are currently eight sunspot regions on the visible disc, the largest and most significant being AR3712. This region continues to develop in size and complexity with at least two small delta spots visible. AR3713 and AR3716, both in the eastern hemisphere, have also developed slightly gaining a number of intermediate spots. AR3709, close to centre disc, is a slightly smaller mature region, consisting of a single leader followed by smaller trailing spots and has shown slight decline in recent hours. The other regions are relatively small and simple.

No Earth directed CME's were observed during the period, with a filament eruption at 14/0900 UTC in the southwest not appearing to have produced a CME, with much of the filament material looking like it was reabsorbed.

Solar Wind / Geomagnetic Activity: Solar winds, as observed by ACE at L1, were indicative of a slow regime. The speed was slow-ambient and generally stable, varying between 300-370 km/s, with below average density. The IMF (Interplanetary Magnetic Field), Bt, was weak throughout with a peak of 6 nT. The north-south component, Bz, has been predominantly negative, but has fluctuated weakly at times, with a range of -6 to +2 nT during the period. The phi angle was mostly negative (towards the Sun), with a period of positive (away from the Sun) between 14/0300-0800 UTC. Since 14/1900 UTC the phi angle has fluctuated between positive and negative. Geomagnetic activity was Quiet (Kp0-2).

Energetic Particles / Solar Radiation: The high-energy (greater than 10 MeV) proton flux observed by GOES18 remained below the S1 threshold and has been declining through the period, returning to background levels.

High energy electron flux (greater than 2MeV) observed by GOES16 was at background to moderate, with the associated 24-hour fluence well below Active. Observed fluence at 15/0000 UTC was 1.2e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Further isolated M-class flares are likely, with just a slight chance of X-flares. Any significant flares most likely from AR3712 and AR3713. No new significant regions are expected to rotate onto the visible disc during the period.

Solar Wind / Geomagnetic Activity: A faint CME associated with a M1 flare at 12/2246 UTC is now considered to have an Earth directed component, reaching Earth later on Day 1 or into Day

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2 (15-16 Jun). Confidence is low regarding the arrival time and impact. A high speed stream from CH45/+ may connect to Earth during Day 3 (17 Jun) with uncertain enhancement, perhaps seeing winds increase to 400-500km/s.

Overall, geomagnetic activity is expected to remain Quiet (Kp0-2) initially, before increasing later Day 1 into Day 2 (15-16 Jun) upon arrival of the forecast CME to Active or G1 (Kp4-5), with perhaps a slight chance of reaching Moderate/G2 (Kp6). Geomagnetic levels then Quiet to Unsettled (Kp1-3) for the remainder of the period with a chance of isolated Active (Kp4) intervals associated with the arrival of any coronal hole enhancement.

Energetic Particles / Solar Radiation: High energy proton flux is expected to continue to decline over the coming days, remaining below the S1/Minor storm levels. The chance of enhancement remains low.

High energy electron flux is forecast to persist at predominantly background levels, and the associated 24-hour fluence is expected to remain below the Active threshold.

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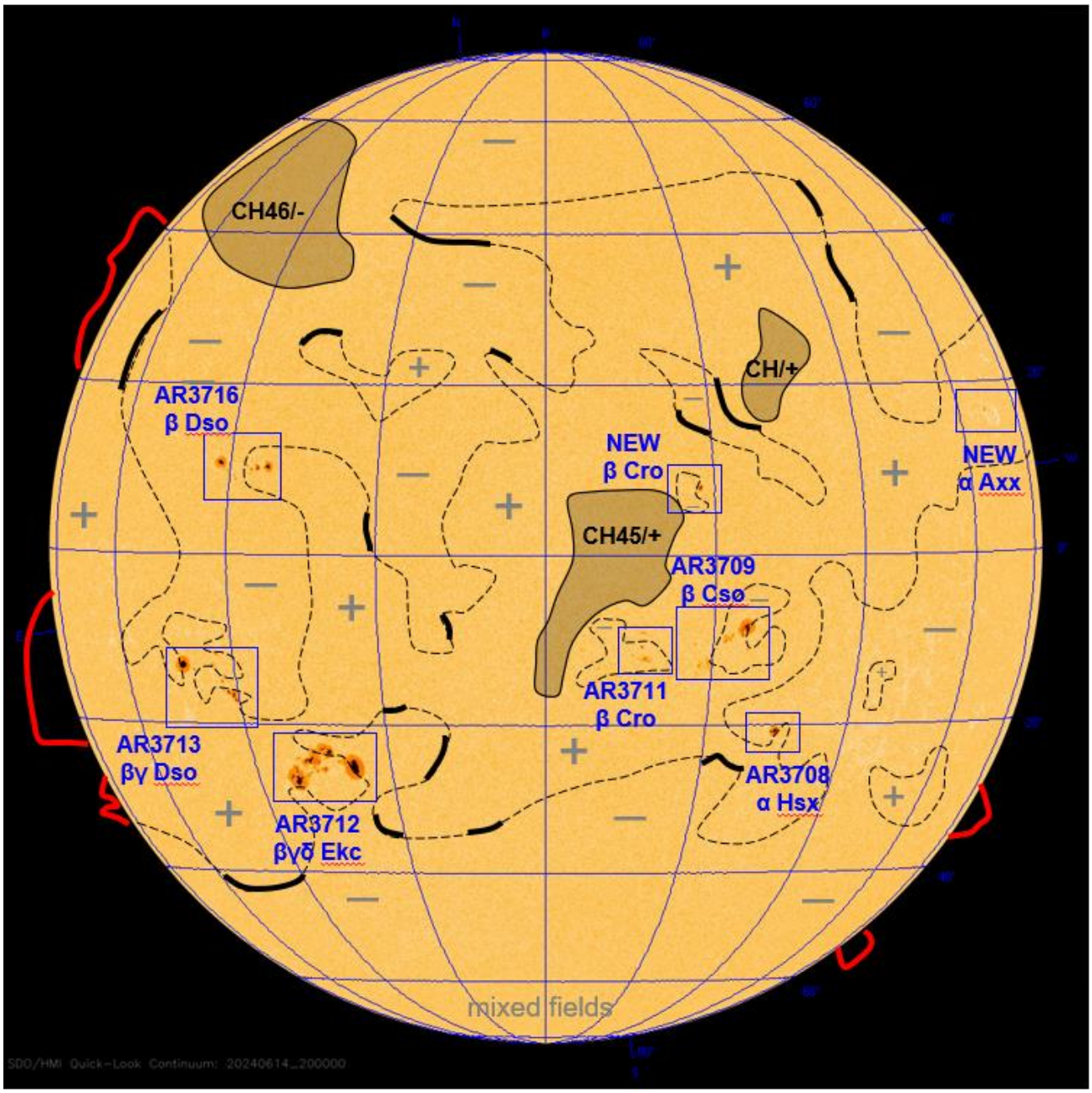
Figure 1. Solar Analysis Valid 14/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A faint CME associated with a M1 flare at 12/2246 UTC from AR3711 has been reanalysed and is considered to have an Earth directed component, reaching Earth later on Day 1 (15 Jun), or possibly into Day 2 (16 Jun). Confidence is low regarding the arrival time and impact, due to the weak nature of the CME and gaps in the imagery for analysis. Currently only G1/Minor Geomagnetic storm intervals (Kp5) are anticipated.

A high speed stream associated with coronal hole feature CH45/+ near centre disc may connect with Earth on Day 3 (17 June). This feature is not recurrent, and so as such, it is difficult to confidently forecast the level of geomagnetic response upon connection. However, due to the proximity to the solstice and the size and the strength of the coronal hole, solar wind speeds of 400-500 km/s are anticipated with the possibility of a few Unsettled or possibly Active (Kp3-4) geomagnetic intervals.

Overall geomagnetic activity is expected to remain Quiet (Kp0-2) initially before increasing later Day 1 into Day 2 (15-16 Jun) upon arrival of the forecast CME to Active or G1 (Kp4-5), with perhaps a slight chance of reaching Moderate/G2 (Kp6). Geomagnetic levels then Quiet to Unsettled (Kp1-3) for the remainder of the period with a chance of isolated Active (Kp4) intervals associated with the arrival of any coronal hole enhancement.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	50	30	5	2
Strong	G3	No	5	5	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
13/0131	Full	AR3711	SE	850 km/s	14/1400 UTC	Low confidence in arrival time.

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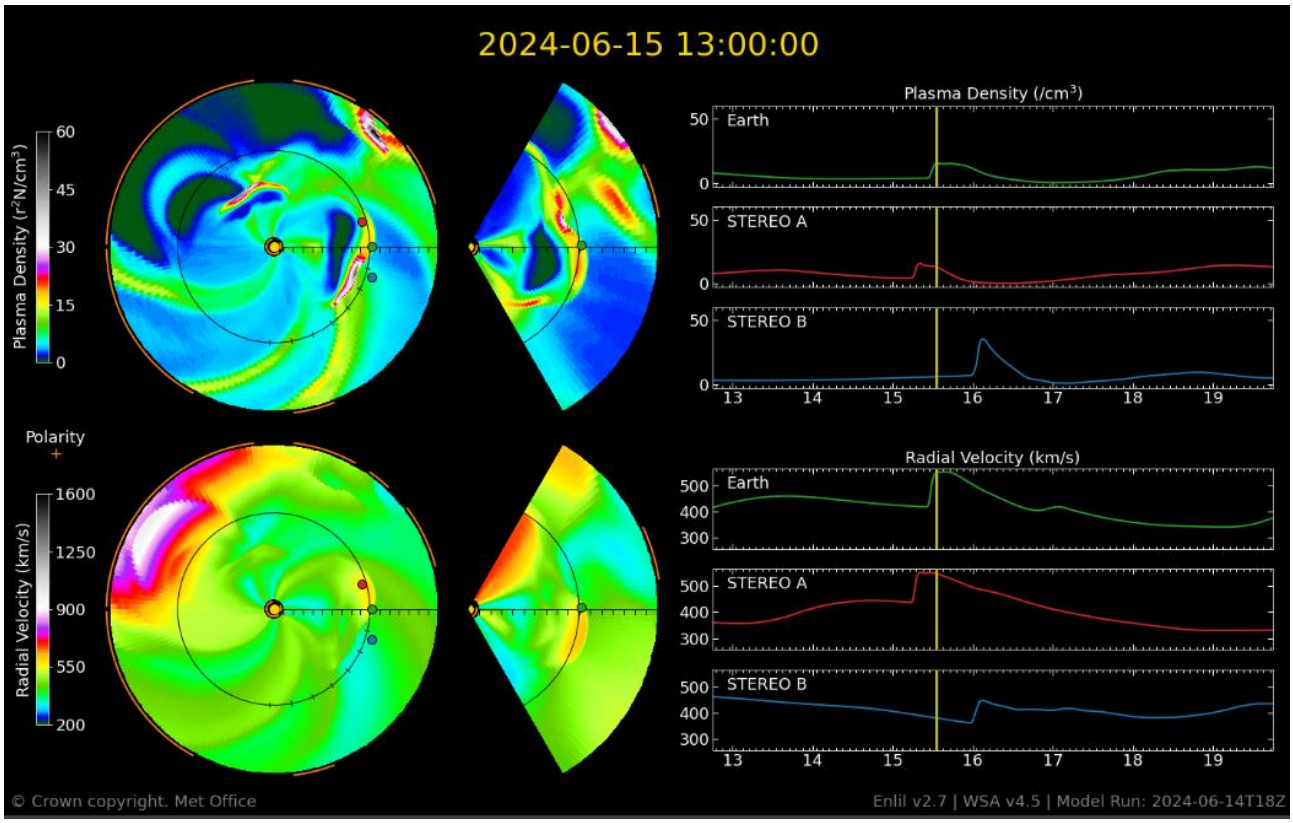
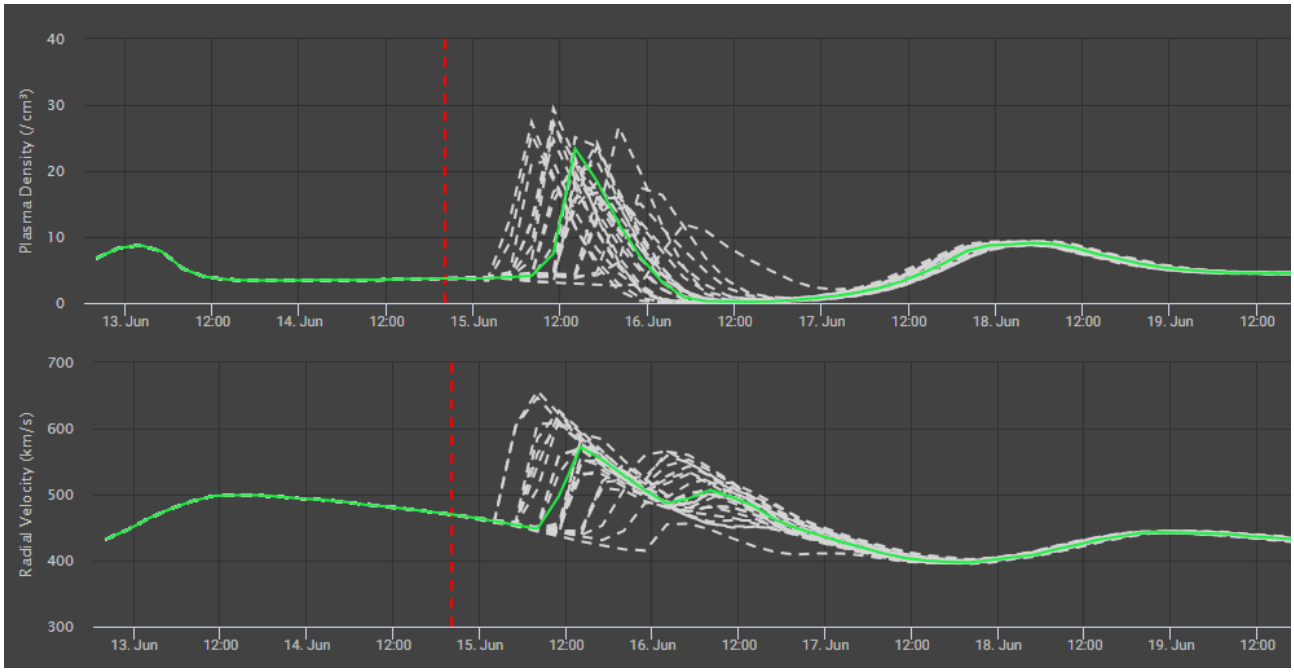
Figure 2: MOSWOC Enlil & ensemble models showing estimated arrival time of faint halo CME.





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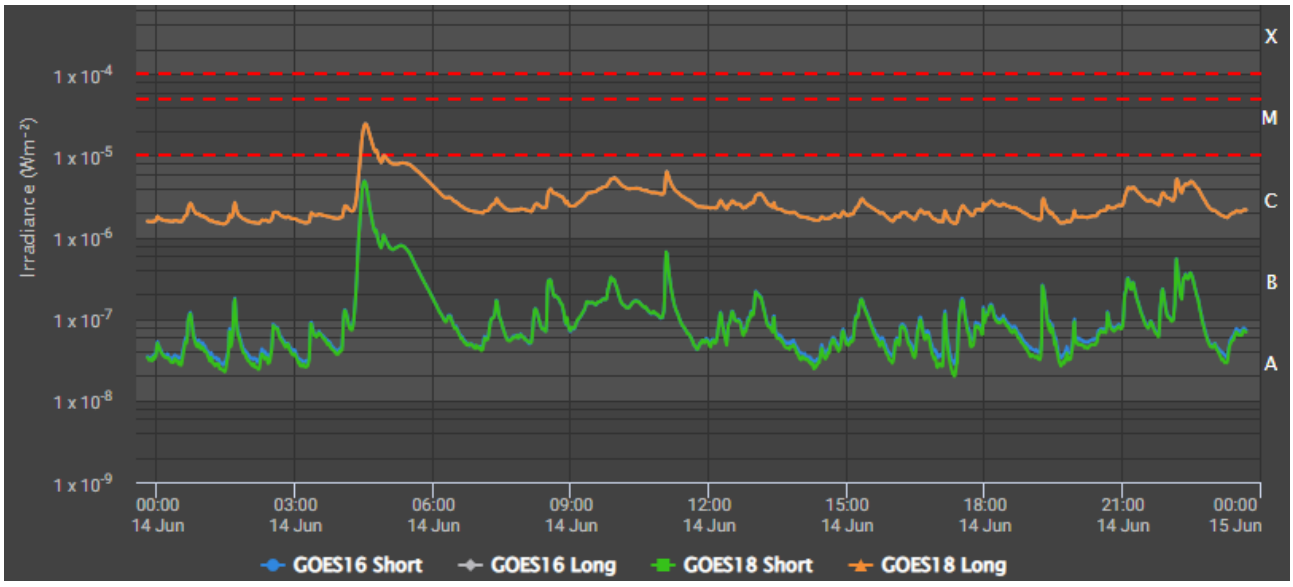
Radio Blackouts - X-Ray Flares:

There are currently eight sunspot regions on the visible disc, with two as yet unnumbered. Activity has been Moderate with the largest flare of the past 24 hours an M2.4 peaking at 14/0432 UTC from AR3712 in the southeast. This region remains the largest and most significant on the disc. It consists of a number of large and strong spots in close proximity, with some consolidation of its intermediate spots, as well as continued areal growth. An increase in penumbra and the slight shearing of a leading spot has been observed as well as the presence of at least two delta spots. AR3713, also in the southeast hemisphere, has seen some proliferation of small spots in its lead portion and remains unchanged in its classification. AR3716 in the north east has seen the emergence of a number of smaller spots in its intermediate portion. The other regions are comparatively small and simple

Further M-class flares are likely through the period, with only a slight chance of X-flares, most likely from AR3712 or AR3713. No new significant regions are expected to rotate onto the disc during the period.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	50	60	60	60
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3: GOES-16 & -18 X-ray flux for past 24hrs.



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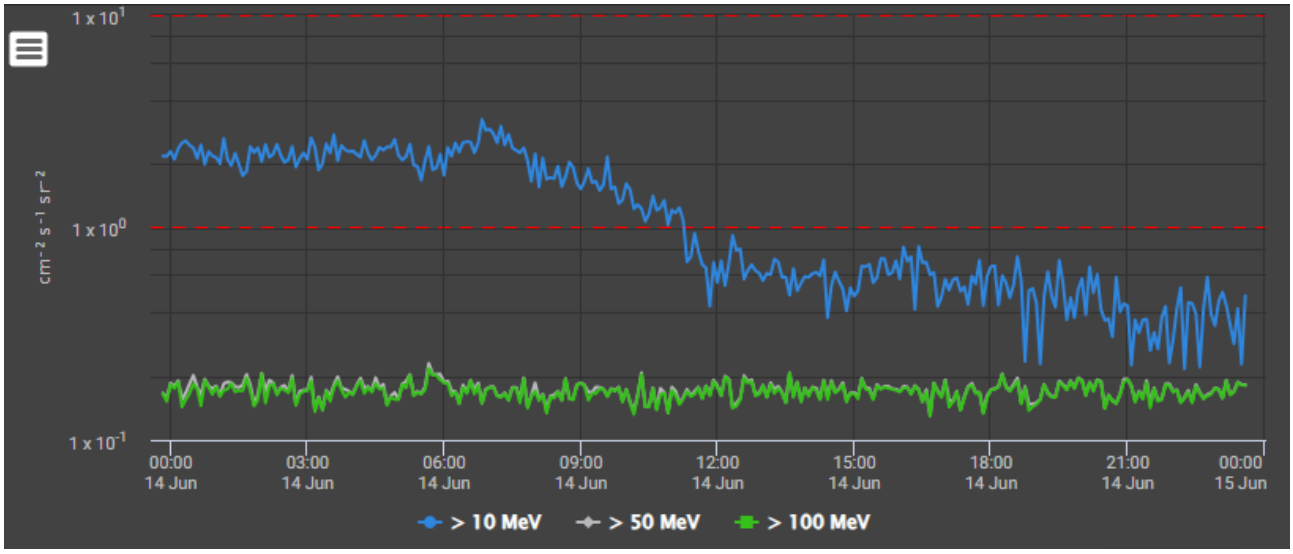
Solar Radiation Storms - (High Energy Protons):
High energy proton flux is expected to continue to decline over the coming days, remaining below the S1/Minor storm levels as previous region AR3697 continues to rotate further across the far side and the most significant regions on the visible disc are currently in the eastern hemisphere. A slight increase towards the end of the period as AR3612 moves into a more centrally located position on the visible disc.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	10
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

Figure 4: GOES-18 Proton flux for the past 24hrs.



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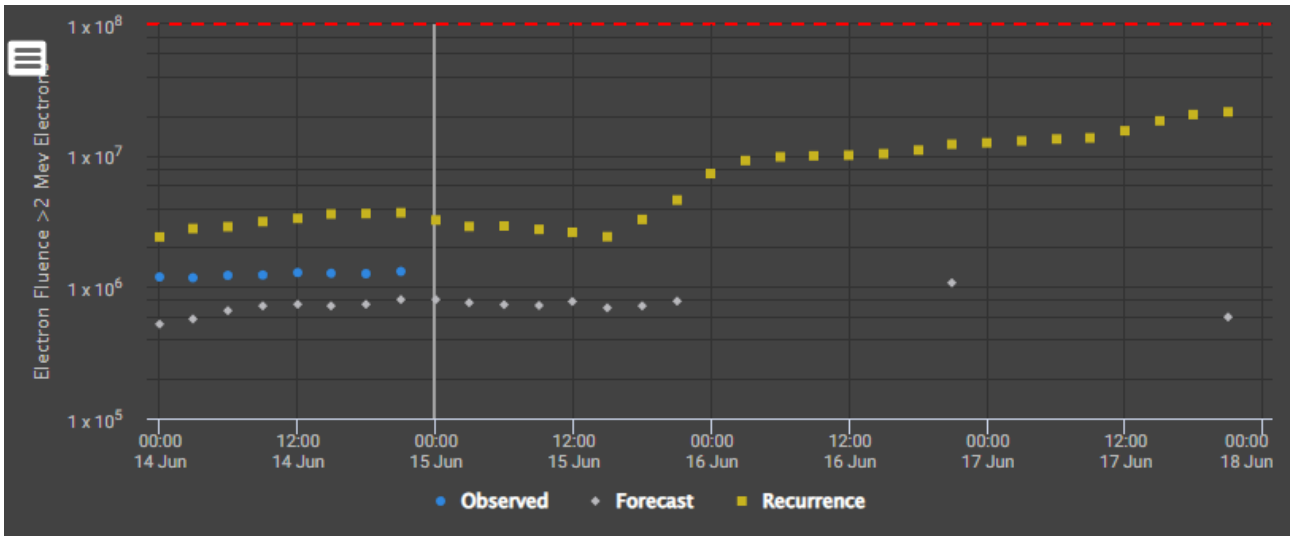
High Energy Electrons Event (≥ 2MeV):
The high energy electron flux is expected to persist at generally background levels for much of this period with no or limited significant sources of enhancement expected. Some diurnal Moderate flux values are likely.

The associated 24 hour fluence is expected to remain well below the Active threshold (1e8 integrated pfu) and the MOSWOC REFM output is considered to provide reasonably good guidance, even if it seems to be slightly underestimating current levels. Any influence from the CME arrival on Day 1 or Day 2 (15-16 Jun) may act to further suppress electron flux values with any recovery or response unlikely during the forecast period.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	1	1
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: MOSWOC REFM model producing reasonable guidance.



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